AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1.   (withdrawn): A surgical system comprising:

a robot connected to a bone, with which is associated an orthopaedic insert having at least one predrilled hole for attaching said insert to said bone;

a drill guiding plate carried by said robot, said guiding plate having at least one hole for guiding a drill into said bone and through said at least one predrilled hole;

an imaging system generating at least one image including said drill guiding plate and said at least one predrilled hole; and

a computational system utilizing data from said at least one image to align said robot such that the axis of said at least one hole defined by said drill guiding plate is aligned essentially colinearly with the axis of said at least one predrilled hole defined by said insert.

2.   (withdrawn): A surgical system according to claim 1 and wherein said axis of said at least one hole defined by said drill guiding plate is aligned essentially colinearly with the axis of said at least one predrilled hole both laterally and in angular orientation.

3.   (withdrawn): A surgical system according to claim 1 and wherein said drill guiding plate comprises a plurality of fiducial markers disposed in a predetermined pattern.

4.   (withdrawn): A surgical system according to claim 3 and wherein said imaging system utilizes said plurality of fiducial markers to align said drill guiding plate by means of said robot such that it images said drill guiding plate in a fronto-parallel orientation.

5.   (withdrawn): A surgical system according to claim 1 , and wherein said imaging system is aligned such that it images said at least one predrilled hole in a fronto-parallel orientation.

6.   (withdrawn): A surgical system according to claim 5 and wherein said computational system aligns said robot by utilizing data from only one image of said imaging system.

7.   (withdrawn): A surgical system according to claim 1 and wherein said robot is directly mounted on said bone.

8.   (withdrawn): A surgical system according to claim 1 and wherein said robot is attached to said insert associated with said bone.

9.   (withdrawn): A surgical system according to claim 1 and wherein said robot maintains its position relative to said bone such that tracking of said bone position is obviated.

10.   (withdrawn): A surgical system according to claim 1 and wherein said robot maintains its position relative to said bone such that immobilization of said bone is obviated.

11.   (withdrawn): A surgical system according to claim 1 and wherein said bone is a long bone, and said orthopaedic insert is an intramedullary nail, and said at least one predrilled hole is a distal locking hole.

12.   (withdrawn): A surgical system according to claim 11 and wherein said robot is attached to the proximal end of said intramedullary nail.

13.   (withdrawn): A surgical system according to claim 1 and wherein said orthopaedic insert is an externally attached connector plate, and said at least one predrilled hole is a connecting hole.

14.   (withdrawn): A surgical system according to claim 13 and wherein said bone is a femur, and said connector plate is a percutaneous compression plate, and said connecting hole accommodates a screw for connecting said plate to the shaft of said femur.

15.   (withdrawn): A surgical system according to claim 13 and wherein said bone is a femur, and said connector plate is a percutaneous compression plate, and said connecting hole accommodates a screw for connecting a fractured head of said femur to its shaft.

16.   (withdrawn): A surgical system according to claim 1 and wherein said imaging system comprises an image intensifier with a calibration ring assembly, adapted to enable at least one of image distortion correction and camera calibration.

17.   (withdrawn): A surgical system according to claim 1 and wherein said robot comprises a miniature parallel robot.

18.   (withdrawn): A surgical system according to claim 17 and wherein said robot comprises at least three actuators mounted on a base member, said actuators being configured for at least one of translational and rotational movement.

19.   (currently amended): ~~An imaging~~ A system for generating spatial alignment with a target having at least one predefined hole, said system comprising:

a target guide having at least a second predefined hole, whose axis is to be brought into coincidence with the axis of said at least one predefined hole of said target;

a robot on which said target guide is mounted, for bringing the axes of said at least one target guide hole and said at least one predefined target hole into coincidence; and

a computation system comprising:

a first position localizing module, which computes the position of said at least one target guide hole from at least one image generated thereof;

a second position localizing module, which computes the position of said at least one target hole from at least one image generated thereof; and

a registration unit adapted to determine a spatial relationship between said at least one

target guide hole and said at least one target hole, such that said at least one target guide hole

provides spatial alignment with said at least one predefined target hole.

20.   (currently amended): ~~An imaging~~ A system according to claim 19, and wherein

said image of said at least one target hole is generated from a fronto-parallel setup, such that said

registration unit determining said spatial relationship between said at least one target guide hole

and said at least one target hole, utilizes a two-dimensional image only.

21.   (currently amended): ~~An imaging~~ A system according to claim 20, and wherein

said fronto-parallel alignment is achieved by determining when said image of said at least one

target hole has a minimum elliptic shape.

22.   (currently amended): ~~An imaging~~ A system according to claim 19, and wherein

said imaging system incorporates distortion correction and camera calibration functions.

23.   (currently amended): ~~An imaging~~ A system according to claim 19, and wherein

said system further comprises a calibration ring assembly for distortion correction and camera

calibration.

24.   (currently amended): ~~An imaging~~ A system according to claim 19, and wherein

said target guide comprises a predetermined pattern of fiducial markers, the images of which are

utilized by said first position localizing module in said computing the position of said at least one

target guide hole.

25.   (currently amended): ~~An imaging~~ A system according to claim 24, and wherein

said first position localizing module, which computes the position of said at least one target

guide hole, comprises:

(i) a fiducial marker position locator and position template determiner;

(ii) an image generator producing a new image of said target guide, comprising said at

least one image of said target guide from which said positions of said fiducial markers have been

morphologically removed;

(iii) a normalized cross correlation calculator for said template at pixel locations with

negative values, determining the centers of said fiducial markers;

(iv) a fiducial searcher for looking in small areas around local maxima found by said

normalized cross correlator; and

(v) a position locator for said targeting guide localization, from the locations of said

fiducials determined in step (iv).

26.   (currently amended): The ~~imaging~~ system according to claim 25, and wherein

said fiducial marker position locator and position template determiner utilizes a Hough transform

method.

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27.   (currently amended): The ~~imaging~~ system according to claim 25, and wherein

said position locator utilizes a principal component analysis procedure.

28.   (currently amended): An ~~imaging~~ system according to claim 19, and wherein said

second position localizing module, which computes the position of said at least one target hole

from an image thereof, comprises:

(i) a contour locator using an edge detection routine, for determining the longitudinal

contours of said target;

(ii) a hole searcher, determining the position of holes in an area between said longitudinal

contours in an image of said target, using a detector for regions with the maximal number of

edge elements in windows of dimensions similar to that of said hole moved over said contour;

and

(iii) an ellipse fitter for said edge elements in each of said regions detected.

29.   (currently amended): An ~~imaging~~ system according to claim 19, and wherein said

edge detection routine is a Canny edge detector with sub-pixel edge localization.

30.   (currently amended): An ~~imaging~~ system according to claim 19, and wherein said

registration unit adapted to determine a spatial relationship between said at least one target guide

hole and said at least one target hole, comprises:

an aligner to bring said image of said at least one target hole to a fronto-parallel

configuration such that said at least one image of said target hole has a minimal elliptic shape;

a target guide aligner routine, such that said at least one image of said target guide hole

has a minimal elliptic shape; and

a target guide lateral translator so that the positions of the axes of said target guide hole

and said target hole coincide.

31.   (currently amended): In an imaging system, a method of bringing the positions of

the axes of a hole defined by a target guide and a hole defined by ~~said~~ a target into coincidence,

comprising the steps of :

using said imaging system to obtain at least one image of said target guide hole, such that

~~localizing~~ the position of said target guide hole can be localized from said at least one image

~~thereof~~;

using said imaging system to obtain at least one image of said target hole, such that

~~localizing~~ the axis of said target hole can be localized from said at least one image ~~thereof~~; and

registering said localized target guide hole with said axis of said target hole.

32.   (previously presented): The method of claim 31, and also comprising the initial

step of image distortion correction and calibration of said imaging system utilized to obtain said

images of said target guide hole and said target hole.

33.   (previously presented): The method of claim 31 , wherein said target guide

comprises a predetermined pattern of fiducial markers, and said localizing the position of said

target guide hole is performed by determining the imaged position of said fiducial markers in

said target guide.

34.   (original): The method of claim 33, wherein said determining the imaged position

of said fiducial markers in said target guide comprises the steps of:

(i) detecting the positions of said fiducial markers and inferring a template from their

positions;

(ii) generating a new image of said target guide, comprising said at least one image of

said target guide from which said positions of said fiducial markers have been morphologically

removed;

(iii) computing a normalized cross correlation value of said template at pixel locations

with negative values to determine the centers of said fiducial markers;

(iv) searching for fiducials in a small area around local maxima of said normalized cross

correlation; and

(v) determining the position of said targeting guide from the locations of said fiducials

determined in step (iv).

35.   (original): The method of claim 34, wherein said step of detecting the positions

of said fiducial markers is performed using a Hough transform.

36.   (original): The method of claim 34, wherein said step of determining the position

of said targeting guide from the locations of said fiducials is performed using a principal

component analysis procedure.

37.   (currently amended): The method of claim 31-2, wherein said localizing the axis

of said target hole from at least one image thereof is performed by the steps of:

(i) locating the longitudinal contours of said target using an edge detection routine;

(ii) searching for a hole in an area between said longitudinal contours in an image of said

target by detecting regions with the maximal number of edge elements in windows of dimensions

similar to that of said hole moved over said contour; and

(iii) fitting an ellipse to said edge elements in each of said regions detected.

38.   (original): The method of claim 37 wherein said edge detection routine is a

Canny edge detector with sub-pixel edge localization.

39.   (previously presented): The method of claim 31 , wherein said registering said

localized target guide hole with said axis of said target hole is performed by the steps of:

adjusting said imaging system to a fronto-parallel configuration such that said at least one

image of said target hole has a minimal elliptic shape;

aligning said target guide such that said at least one image of said target guide hole has a

minimal elliptic shape; and

translating said target guide laterally so that the positions of the axes of said target guide

hole and said target hole coincide.

40.   (canceled).

41.   (currently amended): ~~An imaging~~ A system according to ~~claim 40~~ claim 44, and

wherein said target guide is a drill guiding plate carried by said robot, and said at least one target

guide hole is a drill guiding hole.

42.   (currently amended): ~~An imaging~~ A system according to ~~claim 40~~ claim 44, and

wherein said robot is adapted to be mounted on said bone.

43.   (currently amended): ~~An imaging~~ A system according to claim 41, and wherein

said robot aligns said drill guiding plate such that the axis of said drill guiding hole is aligned

essentially collinear with the axis of said predefined hole in said orthopaedic insert.

44.   (new): A system for generating spatial alignment with an orthopaedic insert

having at least one predefined hole adapted to attach said insert to a bone of a subject, said

system comprising:

a target guide having at least a second predefined hole, whose axis is to be brought into

coincidence with the axis of said at least one predefined hole of said orthopaedic insert;

a robot on which said target guide is mounted, for bringing the axes of said at least one

target guide hole and said at least one predefined orthopaedic insert hole into coincidence; and

a computation system comprising:

a first position localizing module, which computes the position of said at least one target

guide hole from at least one image generated thereof;

a second position localizing module, which computes the position of said at least one

orthopaedic insert hole from at least one image generated thereof; and

a registration unit adapted to determine a spatial relationship between said at least one

target guide hole and said at least one orthopaedic insert hole, such that said at least one target

guide hole provides spatial alignment with said at least one predefined orthopaedic insert hole.